

REMARKS

Attached is an Excess Claims Letter and fee for the independent claims in excess of three.

Claims 1-5, 7 and 15-28 are pending in the application. This Amendment amends claims 1, 4, 5, 17, 20 and 23, cancels claims 6 and 25 without prejudice or disclaimer, and adds claims 26-28. No new matter is added to amended claims 1, 4, 5, 17, 20 and 23 or to new claims 26-28. Claims 1, 4, 5, 17, 20 and 23 are amended to merely clarify the subject matter of the claims and in no way narrow the scope of the claims in order to overcome the prior art or for any other statutory purpose of patentability. Notwithstanding any claim amendments of the present Amendment or those amendments that may be made later during prosecution, Applicant's intent is to encompass equivalents of all claim elements.

Reconsideration in view of the foregoing amendments and the following remarks is respectfully requested.

Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached pages are captioned "Version with markings to show changes made."

Claims 1-6, 17-23 and 25 stand rejected under 35 U.S.C. §102(e) as anticipated by U.S. Patent No. 6,111,301 to Stamper. Claims 7, 15 and 24 stand rejected under 35 U.S.C. §103(a) as unpatentable over Stamper as applied to claims 1 and 20 above, and further in view of U.S. Patent No. 6,162,686 to Huang et al. (hereinafter, Huang).

Claims 1-7, 15 and 16 stand rejected under 35 U.S.C. §112, first paragraph. Claim 25 stands rejected under 35 U.S.C. §112, second paragraph.

These rejections are respectfully traversed in view of the following discussion.

I. THE CLAIMED INVENTION

The claimed invention, as claimed in claim 1, is directed to *inter alia* a semiconductor memory device, including a copper fuse section that is oxidized by a laser beam in an oxidizing environment. The semiconductor memory device includes a dielectric film, a wiring line structure and an opening. The dielectric film includes a first film section formed on a substrate, a second film section formed on the first film section, and a third film section

formed over the second film section. The wiring line structure includes a first and a second wiring line, where each of the first and second wiring lines are formed directly upon the second film section of the dielectric film without an intervening film therebetween and where each extends in an opposite direction, and the copper fuse section that is formed on the first film section of the dielectric film, where an end of the copper fuse section is directly connected to the first wiring line by a first section of the first wiring line, which penetrates a portion of the second film section, and another end of the copper fuse section is directly connected to the second wiring line by a second section of the second wiring line, which penetrates a portion of the second film section. The opening is formed in the third and second film sections of the dielectric film and between the first and second wiring lines, where the opening provides access to the laser beam to oxidize the copper fuse section in the oxidizing environment.

The claimed invention, as claimed in claim 17, is directed to *inter alia* a semiconductor device including a copper fuse, in which the copper fuse is programmed to a high resistance state by oxidation, and where the high resistance state results from a cross section of the copper fuse being oxidized in an oxygen atmosphere to copper oxide.

The claimed invention, as defined in claim 20, contains at least the feature of a semiconductor memory device that includes a copper fuse, where an end of the copper fuse is directly connected to the first wiring line by a first section of the first wiring line, which penetrates a portion of the second film section, and another end of the copper fuse is directly connected to the second wiring line by a second section of the second wiring line, which penetrates a portion of the second film section.

An aspect of the claimed invention provides for a copper fuse that is converted into a high resistance cross section in an oxidizing atmosphere without degradation of a dielectric constant film adjacent to the copper fuse.

II. THE PRIOR ART REJECTIONS

A. The Stamper Reference

Fig. 4 of Stamper discloses a copper fuse 2 that is connected to metal conductors 6, on both left and right sides, through a relatively low resistivity metal 9, such as, copper (col. 3,

lines 11 and 12). Each of the left and right low resistivity metals 9 are surrounded by an unidentified layer on three sides, which may be the copper corrosion barrier 3 (col. 3, lines 9 and 10). The copper corrosion barrier 3 is a corrosion resistant metal, such as, tungsten (W) or titanium nitride (TiN) (col. 2, lines 47-56).

Fig. 2 of Stamper discloses a copper fuse 2 that is connected to copper conductors 6, on both left and right sides, through a corrosion barrier metal 3 (see, col. 3, lines 2-4).

Claims 1 and 20 recites at least the features of "an end of said copper fuse section being directly connected to said first wiring line by a first section of said first wiring line, which penetrates a portion of said second film section, and another end of said copper fuse section being directly connected to said second wiring line by a second section of said second wiring line" and "an end of said copper fuse being directly connected to said first wiring line by a first section of said first wiring line, which penetrates a portion of said second film section, and another end of said copper fuse being directly connected to said second wiring line by a second section of said second wiring line," respectively.

Stamper discloses a copper fuse that is connected to metal conductors 6, which corresponds to the claimed inventions first and second wiring lines, through a corrosion barrier layer. In contrast, the claimed invention recites that the ends of the copper fuse are directly connected to the first and second wiring lines through corresponding sections of the wiring lines. See, in relevant part, page 7, lines 19 and 25-27 of the application, which recite "As shown if Fig. 1 ... [t]he wiring line structure 2 is composed of wiring lines 4, 5, 12 and 13 and a fuse section 11." Nowhere does the claimed invention separate the copper fuse 11 from the wiring lines 4, 12 and 5, 13 because the fuse and wiring lines are integral to the wiring line structure 2. Therefore, Stamper does not teach or suggest "an end of said copper fuse section being directly connected to said first wiring line by a first section of said first wiring line, which penetrates a portion of said second film section, and another end of said copper fuse section being directly connected to said second wiring line by a second section of said second wiring line" and "an end of said copper fuse being directly connected to said first wiring line by a first section of said first wiring line, which penetrates a portion of said second film section, and another end of said copper fuse being directly connected to said second wiring line by a second section of said second wiring line," as recited in claims 1 and

20, respectively.

For at least the reasons outlined above, Applicant respectfully submits that Stamper does not teach or suggest every feature of claims 1, 17 and 20. Accordingly, Stamper does not anticipate or render obvious the subject matter of claims 1, 17 and 20 and claims 2-5, 18, 19 and 21-23, which depend from claims 1, 17 and 20. By this Amendment, claims 6 and 25 are canceled without prejudice or disclaimer; hence, the rejection of claims 6 and 20 is moot. Withdrawal of the rejection of claims 1-5 and 17-23 under 35 U.S.C. §102(e) as anticipated by Stamper is respectfully solicited.

B. The Huang Reference

Fig. 5 of Huang discloses *inter alia* a plug fuse 58B which is connected through first fuse plugs 38B and contact plugs 26, both being located beneath the plug fuse 58B, to conductive strips 20A, 20B, also located beneath the plug fuse 58B. Conductive strips 20A, 20B penetrate the first insulating layer 24, the second insulating layer 30 and the intermetal dielectric layer 42 to contact the metal layer 44, M2.

Huang does not cure the deficiencies of Stamper. Nowhere does Huang teach or suggest "an end of said copper fuse section being directly connected to said first wiring line by a first section of said first wiring line, which penetrates a portion of said second film section, and another end of said copper fuse section being directly connected to said second wiring line by a second section of said second wiring line" and "an end of said copper fuse being directly connected to said first wiring line by a first section of said first wiring line, which penetrates a portion of said second film section, and another end of said copper fuse being directly connected to said second wiring line by a second section of said second wiring line," as recited in claims 1 and 20, respectively.

For at least the reasons outlined above, Applicant respectfully submits that Stamper and Huang either in individually or in combination fail to teach or suggest every feature of claims 1 and 20. Accordingly, Stamper and Huang either in individually or in combination fail to render obvious the subject matter of claims 1 and 20 and claims 7, 15 and 24, which depend from claims 1 and 20 under 35 U.S.C. §103(a). Withdrawal of the rejection of claims 7, 15 and 24 under 35 U.S.C. §103(a) over Stamper as applied to claims 1 and 20, above, and

further in view of Huang is respectfully solicited.

For the reasons stated above, the claimed invention is fully patentable over the cited references.

III. THE 35 U.S.C. §112, FIRST AND SECOND PARAGRAPH, REJECTIONS

Claims 1-7, 15 and 16 are rejected under 35 U.S.C. §112, first paragraph. Applicant respectfully submits that independent claim 1 is amended to describe in relevant part, "a wiring line structure, including ... said copper fuse section formed on said first film section of said dielectric film, an end of said copper fuse section being directly connected to said first wiring line by a first section of said first wiring line, which penetrates a portion of said second film section, and another end of said copper fuse section being directly connected to said second wiring line by a second section of said second wiring line, which penetrates a portion of said second film section" The support for such an amendment is found on page 7, lines 19 and 25-27 of the application, which recite "As shown in Fig. 1 ... [t]he wiring line structure 2 is composed of wiring lines 4, 5, 12 and 13 and a fuse section 11."

Applicant respectfully solicits the withdrawal of the rejection of claims 1-7, 15 and 16 under 35 U.S.C. §112, first paragraph.

Claim 25 is rejected under 35 U.S.C. §112, second paragraph. By this Amendment, claim 25 is canceled without prejudice or disclaimer. Hence, the rejection of claim 25 under 35 U.S.C. §112, second paragraph is moot.

IV. FORMAL MATTERS AND CONCLUSION

The Office Action objects to the drawings and the specification because of the following recitation of claim 1, "an end of said copper fuse section being connected to said first wiring line without an intervening film therebetween and another end of said copper section being connected to said second wiring line without an intervening film therebetween."

However, as stated above, claim 1 is amended to recite "a wiring line structure, including ... said copper fuse section formed on said first film section of said dielectric film, an end of said copper fuse section being directly connected to said first wiring line by a first section of said first wiring line, which penetrates a portion of said second film section, and

another end of said copper fuse section being directly connected to said second wiring line by a second section of said second wiring line, which penetrates a portion of said second film section" The support for such an amendment is found on page 7, lines 19 and 25-27 of the application, which recite "As shown in Fig. 1 ... [t]he wiring line structure 2 is composed of wiring lines 4, 5, 12 and 13 and a fuse section 11." Therefore, Applicant respectfully submits that neither the drawings, nor the specification need be amended.

In view of the foregoing, Applicant submits that claims 1-5, 7, 15-24, and 26-28 all the claims presently being considered in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

Date: 9/5/02

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Please amend claims 1, 4, 5, 17, 20 and 23 as follows:

1. ([Twice] Thrice Amended) A semiconductor memory device, including a copper fuse section that is oxidized by a laser beam in an oxidizing environment, comprising:

 a dielectric film including a first film section formed on a substrate, a second film section formed on said first film section, and a third film section formed over said second film section;

 a wiring line structure, including:

 a first and a second wiring line, each of said first and second wiring lines formed directly upon said second film section of said dielectric film without an intervening film therebetween and extending in an opposite direction, and

 said copper fuse section formed on said first film section of said dielectric film, an end of said copper fuse section being directly connected to said first wiring line [without an intervening film therebetween] by a first section of said first wiring line, which penetrates a portion of said second film section, and another end of said copper fuse section being directly connected to said second wiring line [without an intervening film therebetween] by a second section of said second wiring line, which penetrates a portion of said second film section; and

 an opening formed in said third and second film sections of said dielectric film and between said first and second wiring lines, wherein said opening provides access to said laser beam to oxidize said copper fuse section in said oxidizing environment.

4. (Twice Amended) A semiconductor memory device according to claim 1, wherein at least one of said first wiring line, said first section of said first wiring line, said second wiring line, and said second section of said second wiring [lines] line includes copper.

5. (Twice Amended) A semiconductor memory device according to claim 2, wherein at least one of said first wiring line, said first section of said first wiring line, said second wiring line, and said second section of said second wiring [lines] line includes copper.

17. (Amended) A semiconductor device including a copper fuse, said copper fuse being programmed to a high resistance state by oxidation, wherein said high resistance state results from a cross section of said copper fuse being oxidized in an oxygen atmosphere to copper oxide.

20. (Amended) A semiconductor device that includes a copper fuse, comprising:
a dielectric film including a first film section formed over a substrate, a second film section formed on said first film section, and a third film section formed on said second film section;

a first wiring line and a second wiring line, each of said first wiring line and said second wiring line being formed on said second film section of said dielectric film;

said copper fuse formed on said first film section of said dielectric film, an end of said copper fuse being directly connected to said first wiring line by a first section of said first wiring line, which penetrates a portion of said second film section, and another end of said copper fuse being directly connected to said second wiring line by a second section of said second wiring line, which penetrates a portion of said second film section, and said copper fuse being programmed to a high resistance state by oxidation; and

an opening formed in said third and second film sections of said dielectric film and between said first wiring line and said second wiring line,

wherein said high resistance state results from a cross section of said copper fuse being oxidized to copper oxide and said cross section is located in said opening.

23. The semiconductor device according to claim 20, wherein at least one of said first wiring line [and], said first section of said first wiring line, said second wiring line and said second section of said wiring line includes copper.